3.7 Equivalent Circuits: Resistors and Sources

We have found that the way to think about circuits is to locate and group parallel and series resistor combinations. Those resistors not involved with variables of interest can be collapsed into a single resistance. This result is known as an **equivalent circuit**: from the viewpoint of a pair of terminals, a group of resistors functions as a single resistor, the resistance of which can usually be found by applying the parallel and series rules.

This result generalizes to include sources in a very interesting and useful way. Let's consider our simple attenuator circuit (shown in the figure (Figure 3.16) from the viewpoint of the output terminals. We want to find the **v-i** relation for the output terminal pair, and then find the equivalent circuit for the boxed circuit. Two perform this calculation, use the circuit laws and element relations, but do not attach anything to the output terminals. We seek the relation between v and i that describes the kind of element that lurks within the dashed box. The result is

$$v = (R_1||R_2)i + \frac{R_2}{R_1 + R_2}v_{in}$$

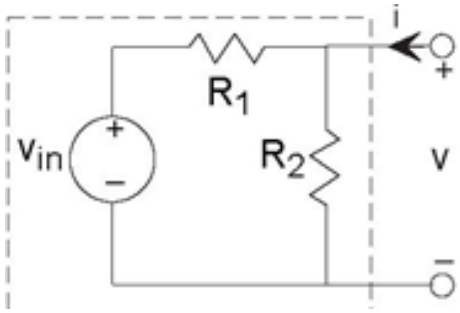

Figure 3.16 Simple attenuator circuit

If the source were zero, it could be replaced by a short circuit, which would confirm that the circuit does indeed function as a parallel combination of resistors. However, the source's presence means that the circuit is **not** well modeled as a resistor.

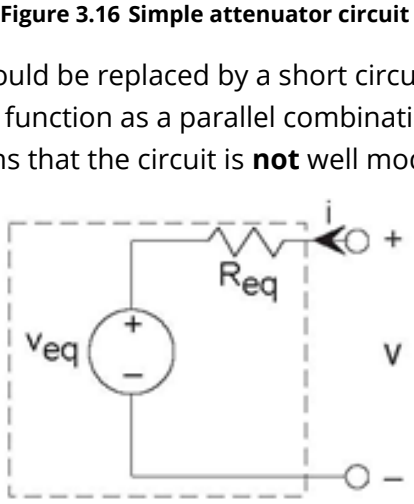

Figure 3.17 The Thevenin equivalent circuit